Data Analysis 101 Workshops

Exploring Data and Descriptive Statistics

(using R)

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Agenda…

- What is R
- Transferring data to R
- Excel to R
- Basic data manipulation
- Frequencies
- Crosstabulations
- Scatterplots/Histograms
- Exercise 1: Data from ICPSR using the *Online Learning Center.*
- Exercise 2: Data from the *World Development Indicators & Global Development Finance* from the World Bank

This document is created from the following:
http://dss.princeton.edu/training/RStata.pdf

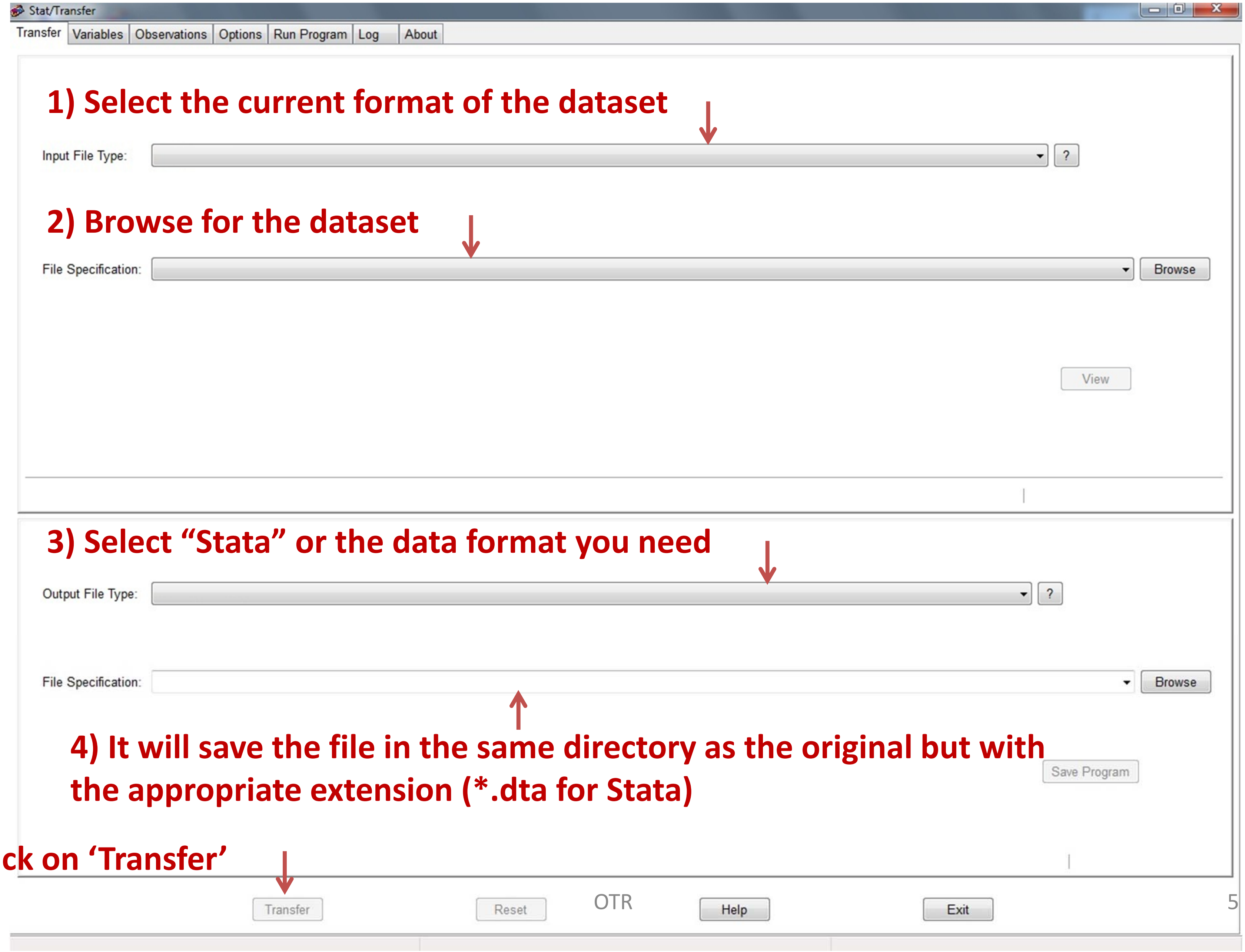
What is R?

- R is a programming language use for statistical analysis and graphics. It is based S-plus. [see http://www.r-project.org/]
- Multiple datasets open at the same time
- R is offered as open source (i.e. free)
- Download R at http://cran.r-project.org/
- A dataset is a collection of several pieces of information called variables (usually arranged by columns). A variable can have one or several values (information for one or several cases).
- Other statistical packages are SPSS, SAS and Stata.

Other data formats…

Features	**Stata**	**SPSS**	**SAS**	**R**
Data extensions	***.dta**	***.sav,** ***.por (portable file)**	***.sas7bcat, *.sas#bcat,** ***.xpt (xport files)**	***.Rdata**
User interface	Programming/point-and-click	Mostly point-and-click	Programming	Programming
Data manipulation	Very strong	Moderate	Very strong	Very strong
Data analysis	Powerful	Powerful	Powerful/versatile	Powerful/versatile
Graphics	Very good	Very good	Good	Excellent
Cost	Affordable (perpetual licenses, renew only when upgrade)	Expensive (but not need to renew until upgrade, long term licenses)	Expensive (yearly renewal)	Open source
Program extensions	*.do (do-files)	*.sps (syntax files)	*.sas	*.txt (log files)
Output extension	*.log (text file, any word processor can read it), *.smcl (formated log, only Stata can read it).	*.spo (only SPSS can read it)	(various formats)	*.R, *.txt(log files, any word processor can read)

Stat/Transfer: Transferring data from one format to another (available in the DSS lab)



1) Select the current format of the dataset

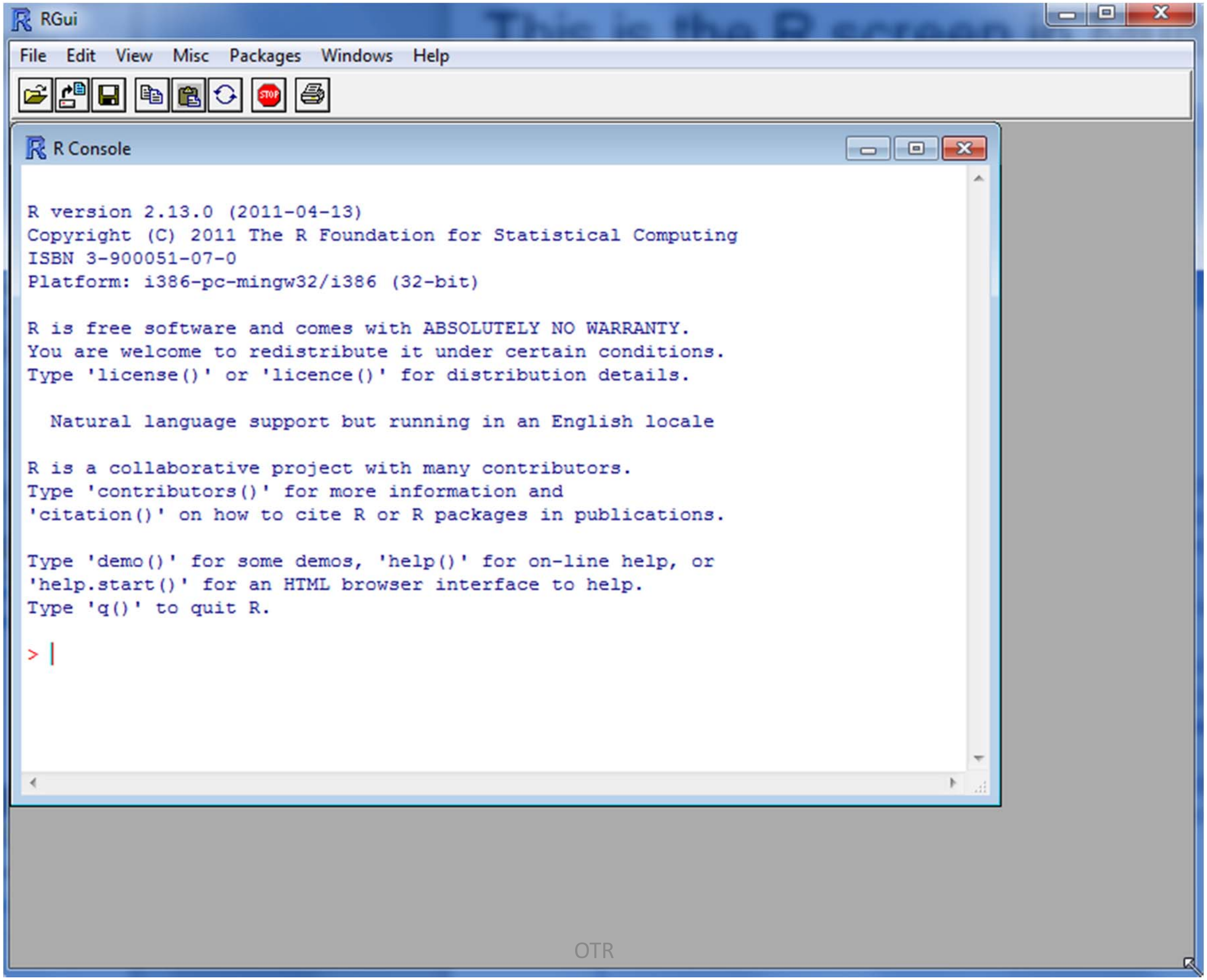
2) Browse for the dataset

3) Select "Stata" or the data format you need

4) It will save the file in the same directory as the original but with the appropriate extension (*.dta for Stata)

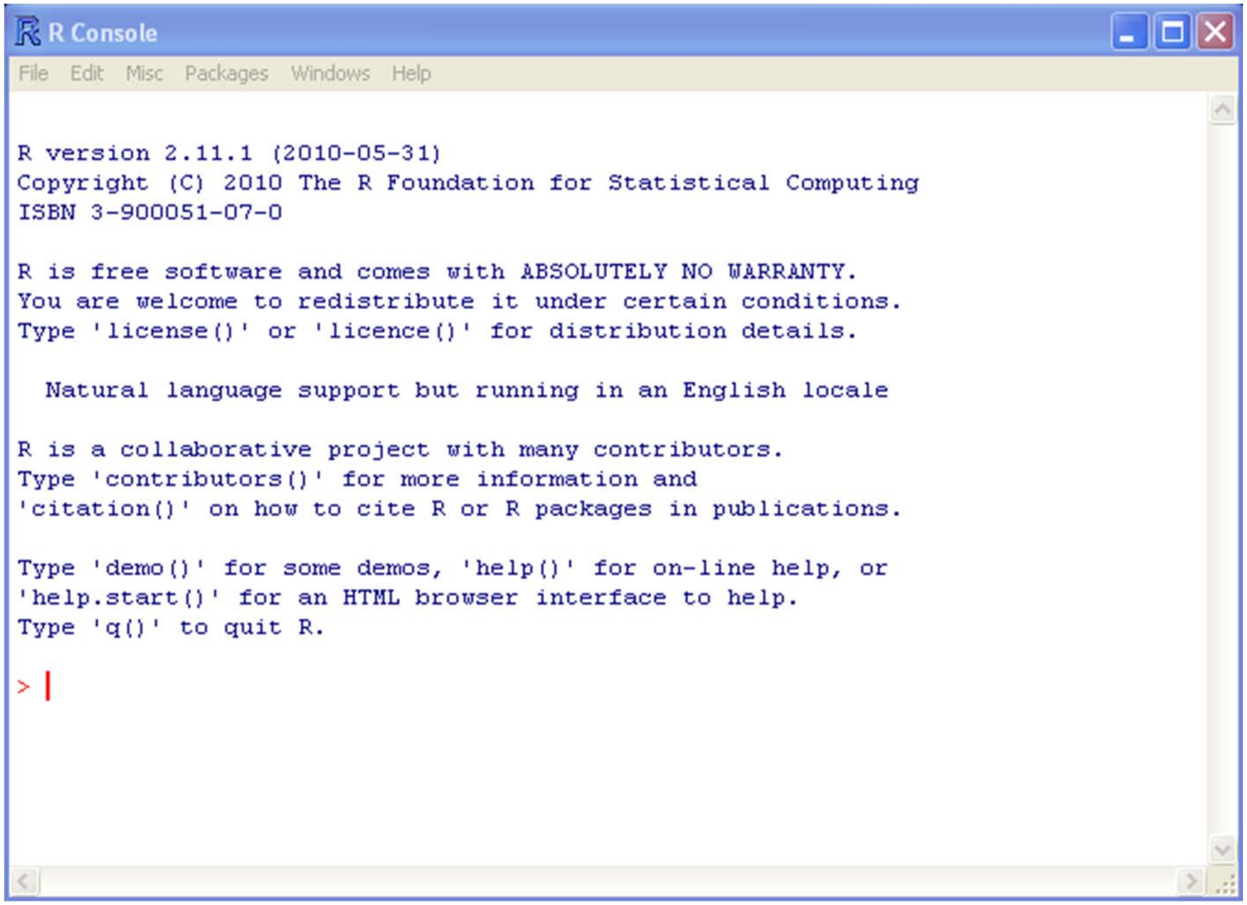
5) Click on 'Transfer'

This is the R screen in Multiple-Document Interface (MDI)…



```
R version 2.13.0 (2011-04-13)
Copyright (C) 2011 The R Foundation for Statistical Computing
ISBN 3-900051-07-0
Platform: i386-pc-mingw32/i386 (32-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> 
```

This is the R screen in Single-Document Interface (SDI)…



```
R version 2.11.1 (2010-05-31)
Copyright (C) 2010 The R Foundation for Statistical Computing
ISBN 3-900051-07-0

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R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> |
```

"…To make the SDI the default, you can select the SDI during installation of R, or edit the Rconsole configuration file in R's etc directory, changing the line MDI = yes to MDI = no. Alternatively, you can create a second desktop icon for R to run R in SDI mode:

- Make a copy of the R icon by right-clicking on the icon and dragging it to a new location on the desktop. Release the mouse button and select *Copy Here*.
- Right-click on the new icon and select *Properties*. Edit the *Target* field on the *Shortcut* tab to read "C:\Program Files\R\R-2.5.1\bin\Rgui.exe" --sdi (including the quotes exactly as shown, and assuming that you've installed R to the default location). Then edit the shortcut name on the *General* tab to read something like R 2.5.1 SDI . " [John Fox, http://socserv.mcmaster.ca/jfox/Books/Companion-1E/installation.html#SDI]

Working directory

```
getwd()   # Shows the working directory (wd)

setwd(choose.dir())   # Select the working directory interactively

setwd("C:/myfolder/data")   # Changes the wd

setwd("H:\\myfolder\\data") # Changes the wd
```

Creating directories/downloading from the internet

```
dir()                    # Lists files in the working directory

dir.create("C:/test")    # Creates folder ‘test’ in drive ‘c:’

setwd("C:/test")         # Changes the working directory to “c:/test”


# Download file ‘students.csv’ from the internet.

download.file("http://dss.princeton.edu/training/students.xls",
     "C:/test/students.xls",
     method="auto",
     quiet=FALSE,
     mode = "wb",
     cacheOK = TRUE)
```

Installing/loading packages/user-written programs

```
install.packages("ABC")   # This will install the package --ABC--. A window will pop-up, select a
                          # mirror site to download from (the closest to where you are) and click ok.

library(ABC)   # Load the package --ABC-- to your workspace

# Install the following packages:

install.packages("foreign")

library(foreign)

install.packages("car")

install.packages("Hmisc")

install.packages("reshape")


http://cran.r-project.org/web/views/      # Full list of packages by subject area
```

Operations/random numbers

```
2+2
Log(10)
c(1, 1) + c(1, 1)

x <- rnorm(10, mean=0, sd=1)   # Creates 10 random numbers (normal dist.), syntax rnorm(n, mean, sd)
x
x <- data.frame(x)
x <- matrix(x)
```

Keeping track of your work

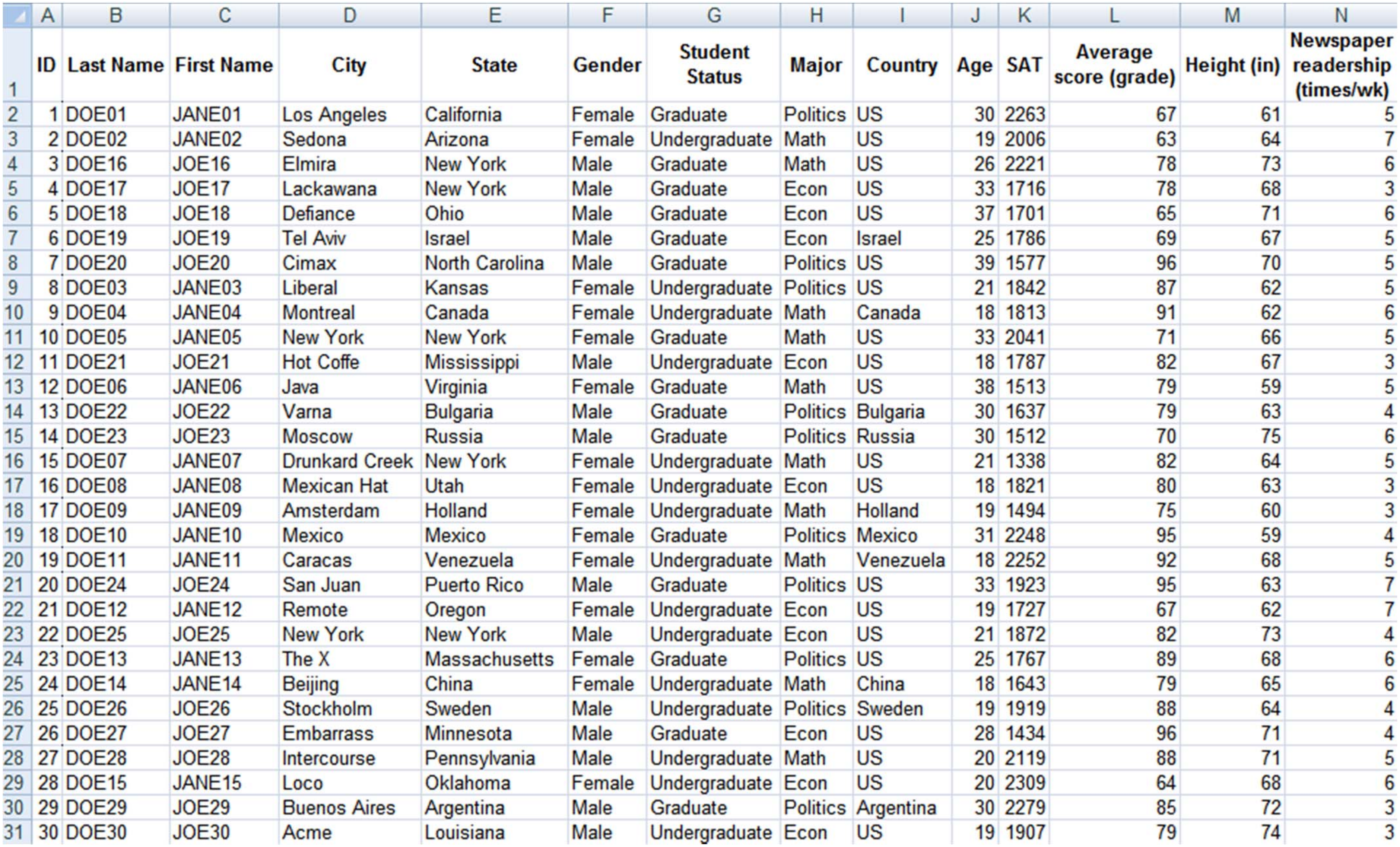
```
# Save the commands used during the session

savehistory(file="mylog.Rhistory")

# Load the commands used in a previous session

loadhistory(file="mylog.Rhistory")

# Display the last 25 commands

history()

# You can read mylog.Rhistory with any word processor. Notice that the file has to have the extension *.Rhistory
```

Getting help

```
?plot # Get help for an object, in this case for the --plot– function. You can also type: help(plot)

??regression # Search the help pages for anything that has the word "regression". You can also type: help.search("regression")

apropos("age")   # Search the word "age" in the objects available in the current R session.

help(package=car)  # View documentation in package ‘car’. You can also type: library(help="car“)

help(DataABC)   # Access codebook for a dataset called ‘DataABC’ in the package ABC

args(log)     # Description of the command.
```

Example of a dataset in Excel.

Variables are arranged by columns and cases by rows. Each variable has more than one value

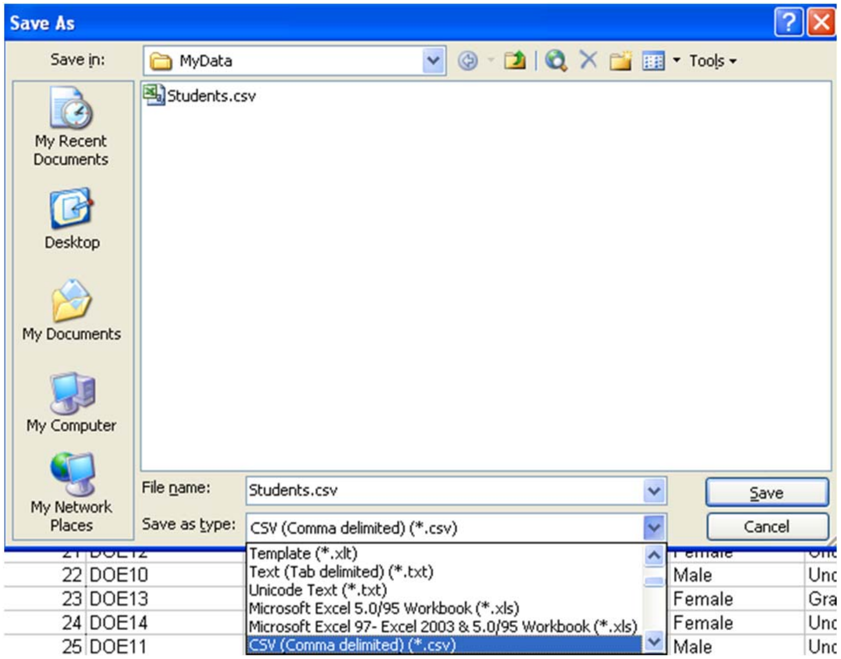


	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	ID	Last Name	First Name	City	State	Gender	Student Status	Major	Country	Age	SAT	Average score (grade)	Height (in)	Newspaper readership (times/wk)
2	1	DOE01	JANE01	Los Angeles	California	Female	Graduate	Politics	US	30	2263	67	61	5
3	2	DOE02	JANE02	Sedona	Arizona	Female	Undergraduate	Math	US	19	2006	63	64	7
4	3	DOE16	JOE16	Elmira	New York	Male	Graduate	Math	US	26	2221	78	73	6
5	4	DOE17	JOE17	Lackawana	New York	Male	Graduate	Econ	US	33	1716	78	68	3
6	5	DOE18	JOE18	Defiance	Ohio	Male	Graduate	Econ	US	37	1701	65	71	6
7	6	DOE19	JOE19	Tel Aviv	Israel	Male	Graduate	Econ	Israel	25	1786	69	67	5
8	7	DOE20	JOE20	Cimax	North Carolina	Male	Graduate	Politics	US	39	1577	96	70	5
9	8	DOE03	JANE03	Liberal	Kansas	Female	Undergraduate	Politics	US	21	1842	87	62	5
10	9	DOE04	JANE04	Montreal	Canada	Female	Undergraduate	Math	Canada	18	1813	91	62	6
11	10	DOE05	JANE05	New York	New York	Female	Graduate	Math	US	33	2041	71	66	5
12	11	DOE21	JOE21	Hot Coffe	Mississippi	Male	Undergraduate	Econ	US	18	1787	82	67	3
13	12	DOE06	JANE06	Java	Virginia	Female	Graduate	Math	US	38	1513	79	59	5
14	13	DOE22	JOE22	Varna	Bulgaria	Male	Graduate	Politics	Bulgaria	30	1637	79	63	4
15	14	DOE23	JOE23	Moscow	Russia	Male	Graduate	Politics	Russia	30	1512	70	75	6
16	15	DOE07	JANE07	Drunkard Creek	New York	Female	Undergraduate	Math	US	21	1338	82	64	5
17	16	DOE08	JANE08	Mexican Hat	Utah	Female	Undergraduate	Econ	US	18	1821	80	63	3
18	17	DOE09	JANE09	Amsterdam	Holland	Female	Undergraduate	Math	Holland	19	1494	75	60	3
19	18	DOE10	JANE10	Mexico	Mexico	Female	Graduate	Politics	Mexico	31	2248	95	59	4
20	19	DOE11	JANE11	Caracas	Venezuela	Female	Undergraduate	Math	Venezuela	18	2252	92	68	5
21	20	DOE24	JOE24	San Juan	Puerto Rico	Male	Graduate	Politics	US	33	1923	95	63	7
22	21	DOE12	JANE12	Remote	Oregon	Female	Undergraduate	Econ	US	19	1727	67	62	7
23	22	DOE25	JOE25	New York	New York	Male	Undergraduate	Econ	US	21	1872	82	73	4
24	23	DOE13	JANE13	The X	Massachusetts	Female	Graduate	Politics	US	25	1767	89	68	6
25	24	DOE14	JANE14	Beijing	China	Female	Undergraduate	Math	China	18	1643	79	65	6
26	25	DOE26	JOE26	Stockholm	Sweden	Male	Undergraduate	Politics	Sweden	19	1919	88	64	4
27	26	DOE27	JOE27	Embarrass	Minnesota	Male	Graduate	Econ	US	28	1434	96	71	4
28	27	DOE28	JOE28	Intercourse	Pennsylvania	Male	Undergraduate	Math	US	20	2119	88	71	5
29	28	DOE15	JANE15	Loco	Oklahoma	Female	Undergraduate	Econ	US	20	2309	64	68	6
30	29	DOE29	JOE29	Buenos Aires	Argentina	Male	Graduate	Politics	Argentina	30	2279	85	72	3
31	30	DOE30	JOE30	Acme	Louisiana	Male	Undergraduate	Econ	US	19	1907	79	74	3

Path to the file: http://dss.princeton.edu/training/students.xls

From Excel to *.csv

In **Excel** go to `File->Save` as and save the Excel file as *.csv:


Save As
Save in: MyData
My Recent Documents
Desktop
My Documents
My Computer
My Network Places
Tools
Save
Cancel
Template (*.xlt)
Text (Tab delimited) (*.txt)
Unicode Text (*.txt)
Microsoft Excel 5.0/95 Workbook (*.xls)
Microsoft Excel 97- Excel 2003 & 5.0/95 Workbook (*.xls)
CSV (Comma delimited) (*.csv)

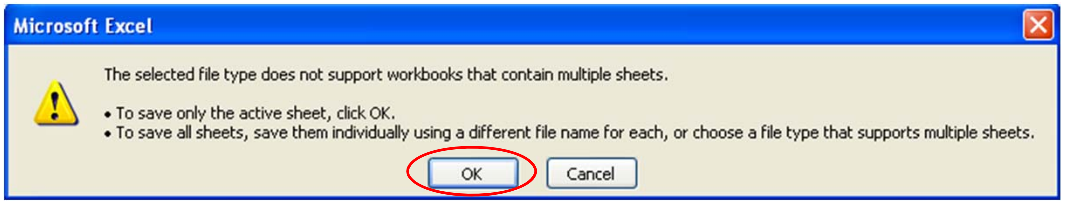
Students.csv

File name: Students.csv

Save as type: CSV (Comma delimited) (*.csv)

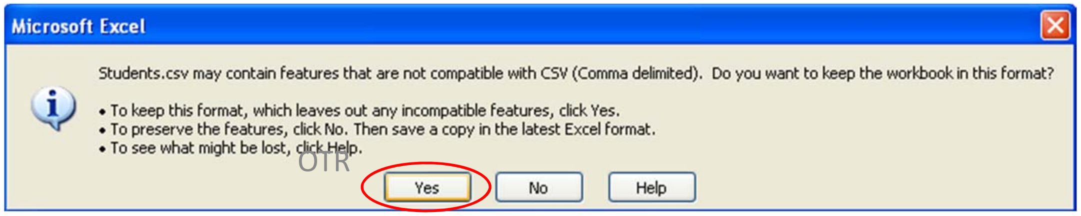
22	DOE10	Male	Unc
23	DOE13	Female	Gra
24	DOE14	Female	Unc
25	DOE11	Male	Unc

You may get the following messages, click OK and YES…



The selected file type does not support workbooks that contain multiple sheets.

- To save only the active sheet, click OK.
- To save all sheets, save them individually using a different file name for each, or choose a file type that supports multiple sheets.



Students.csv may contain features that are not compatible with CSV (Comma delimited). Do you want to keep the workbook in this format?

- To keep this format, which leaves out any incompatible features, click Yes.
- To preserve the features, click No. Then save a copy in the latest Excel format.
- To see what might be lost, click Help.

Data from *.csv (copy-and-paste)

```
# Select the table from the excel file, copy, go to the R Console and type:

mydata <- read.table("clipboard", header=TRUE, sep="\t")

summary(mydata)
edit(mydata)
```

Data from *.csv (interactively)

```
mydata <- read.csv(file.choose(), header = TRUE)
```

Data from *.csv

```
mydata <- read.csv("c:\mydata\mydatafile.csv", header=TRUE)

mydata <- read.csv("http://dss.princeton.edu/training/students.csv", header=TRUE)
```

Data from *.txt (space , tab, comma-separated)

```
# If you have spaces and missing data is coded as ‘-9’, type:

mydata <- read.table(("C:/myfolder/abc.txt", header=TRUE, sep="\t", na.strings = "-9")
```

Data to *.txt (space , tab, comma-separated)

```
write.table(mydata, file = "test.txt", sep = "\t")
```

Data from Stata

```
install.packages("foreign")   # Need to install package --foreign-- first (you do this only once)

library(foreign) # Load package –-foreign--

mydata.stata <- read.dta("http://dss.princeton.edu/training/students.dta")

mydata.stata <- read.dta("http://dss.princeton.edu/training/mydata.dta",
     convert.factors=TRUE,
     convert.dates=TRUE,
     convert.underscore=TRUE,
     warn.missing.labels=TRUE)

# Where (source: type ?read.dta)

# convert.dates. Convert Stata dates to Date class

# convert.factors. Use Stata value labels to create factors? (version 6.0 or later).

# convert.underscore. Convert "_" in Stata variable names to "." in R names?

# warn.missing.labels. Warn if a variable is specified with value labels and those value labels are
not present in the file.
```

Data to Stata

```
write.dta(mydata, file = "test.dta") # Direct export to Stata

write.foreign(mydata, codefile="test1.do", datafile="test1.raw", package="Stata") # Provide a do-
file to read the *.raw data
```

Data from SPSS

```
install.packages("foreign")   # Need to install package --foreign-- first (you do this only once)

library(foreign) # Load package –-foreign--

mydata.spss <- read.spss("http://dss.princeton.edu/training/mydata.sav",
       to.data.frame = TRUE,
       use.value.labels=TRUE,
       use.missings = to.data.frame)

# Where:
#
# ‘to.data.frame’ return a data frame.
#
# ‘use.value.labels’ Convert variables with value labels into R factors with those levels.
#
# ‘use.missings’ logical: should information on user-defined missing values be used to set the
corresponding values to NA.

Source: type ?read.spss
```

Data to SPSS

```
# Provides a syntax file (*.sps) to read the *.raw data file

write.foreign(mydata, codefile="test2.sps", datafile="test2.raw", package=“SPSS")
```

Data from SAS

```
# To read SAS XPORT format (*.xpt). Package --foreign--

install.packages("foreign")   # Need to install package --foreign–- first (you do this only once)

library(foreign) # Load package --foreign--

mydata.sas <- read.xport("c:/myfolder/mydata.xpt") # NOTE: Does not work for files available online

# Using package --Hmisc—

install.packages(“Hmisc")   # Need to install package –-Hmisc–- first (you do this only once)

library(Hmisc)

mydata.sas <- sasxport.get("http://dss.princeton.edu/training/mydata.xpt")   # It works
```

Data to SAS

```
# It provides a syntax file (*.sas) to read the *.raw data

write.foreign(mydata, codefile="test2.sas", datafile="test2.raw", package=“SAS")
```

NOTE: As an alternative, you can use SAS Universal Viewer (freeware from SAS) to read SAS files and save them as *.csv. Saving the file as *.csv removes variable/value labels, make sure you have the codebook available.

Data from ACII Record form

```
mydata.dat <-read.fwf(file="http://dss.princeton.edu/training/mydata.dat",
       width=c(7, -16, 2, 2, -4, 2, -10, 2, -110, 3, -6, 2),
       col.names=c("w","y","x1","x2","x3", "age", "sex"),
       n=1090)

# Reading ASCII record form, numbers represent the width of variables, negative sign excludes
variables not wanted (you must include these).

# To get the width of the variables you must have a codebook for the data set available (see an
example below).

# To get the widths for unwanted spaces use the formula:

Start of var(t+1) – End of var(t) - 1
```

*Thank you to Scott Kostyshak for useful advice/code.

Data locations usually available in codebooks

Var	Rec	Start	End	Format
var1	1	1	7	F7.2
var2	1	24	25	F2.0
var3	1	26	27	A2
var4	1	32	33	F2.0
var5	1	44	45	A2
var6	1	156	158	A3
var7	1	165	166	A2

Data from R

```
load("mydata.RData")

load("mydata.rda")

/* Add path to data if necessary */
```

Data to R

```
save.image("mywork.RData")  # Saving all objects to file *.RData

save(object1, object2, file=“mywork.rda") # Saving selected objects
```

Exploring data

```
summary(mydata)  # Provides basic descriptive statistics and frequencies.
edit(mydata)     # Open data editor
str(mydata)      # Provides the structure of the dataset

names(mydata)    # Lists variables in the dataset

head(mydata)     # First 6 rows of dataset
head(mydata, n=10)# First 10 rows of dataset
head(mydata, n= -10)  # All rows but the last 10

tail(mydata)     # Last 6 rows
tail(mydata, n=10)    # Last 10 rows
tail(mydata, n= -10)  # All rows but the first 10

mydata[1:10, ]   # First 10 rows
mydata[1:10,1:3] # First 10 rows of data of the first 3 variables
```

Exploring the workspace

```
objects()       # Lists the objects in the workspace

ls()            # Same as objects()

remove()        # Remove objects from the workspace

rm(list=ls())   #clearing memory space

detach(package:ABC)   # Detached packages when no longer need them

search()        # Shows the loaded packages

library()       # Shows the installed packages

dir()           # show files in the working directory
```

Missing data

```
rowSums(is.na(mydata))   # Number of missing per row
colSums(is.na(mydata))   # Number of missing per column/variable
rowMeans(is.na(mydata))*length(mydata)  # No. of missing per row (another way)
                                        # length = num. of variables/elements in an object
# Convert to missing data
mydata[mydata$age=="&  ","age"] <- NA   # NOTE: Notice hidden spaces.
mydata[mydata$age==999,"age"] <- NA

# The function complete.cases() returns a logical vector indicating which cases are complete.
# list rows of data that have missing values
mydata[!complete.cases(mydata),]

# The function na.omit() returns the object with listwise deletion of missing values.
# Creating a new dataset without missing data
mydata1 <- na.omit(mydata)
```

Replacing a value

```
mydata1 <- na.omit(mydata)

mydata1[mydata1$SAT==1787,"SAT"] <- 1800

mydata1[mydata1$Country=="Bulgaria","Country"] <- "US"
```

Renaming variables

```
# Using base commands

fix(mydata)   # Rename interactively.

names(mydata)[3] <- "First"

# Using library --reshape--

library(reshape)

mydata <- rename(mydata, c(Last.Name="Last"))

mydata <- rename(mydata, c(First.Name="First"))

mydata <- rename(mydata, c(Student.Status="Status"))

mydata <- rename(mydata, c(Average.score..grade.="Score"))

mydata <- rename(mydata, c(Height..in.="Height"))

mydata <- rename(mydata, c(Newspaper.readership..times.wk.="Read"))
```

Value labels

```
# Use factor() for nominal data

mydata$sex <- factor(mydata$sex, levels = c(1,2), labels = c("male", "female"))

# Use ordered() for ordinal data

mydata$var2 <- ordered(mydata$var2, levels = c(1,2,3,4), labels = c("Strongly agree", "Somewhat
     agree", "Somewhat disagree", "Strongly disagree"))

# As a new variable.

mydata$var8 <- ordered(mydata$var2, levels = c(1,2,3,4), labels = c("Strongly agree", "Somewhat
     agree", "Somewhat disagree", "Strongly disagree"))
```

Reordering labels

```
levels(mydata$Major)

# Syntax for reorder(categorical variable, numeric variable, desired statistic)

mydata$Major = with(mydata, reorder(Major,Read,mean))   # Order goes from low to high

levels(mydata$Major)

attr(mydata$Major, 'scores')   # Reorder creates an attribute called ‘scores’ (with the statistic

                               # used to reorder the labels, in this case the mean values.


# Mean of reading time: 4.4 for Econ, 5.3 for Math, 4.9 for Politics (using students.xls)
```

Creating ids/sequence of numbers

```
# Creating a variable with a sequence of numbers or to index

# Creating a variable with a sequence of numbers from 1 to n (where ‘n’ is the total number of
observations)

mydata$id <- seq(dim(mydata)[1])

# Creating a variable with the total number of observations

mydata$total <- dim(mydata)[1]

/* Creating a variable with a sequence of numbers from 1 to n per category (where ‘n’ is the total
number of observations in each category)(1) */

mydata <- mydata[order(mydata$group),]
idgroup <- tapply(mydata$group, mydata$group, function(x) seq(1,length(x),1))
mydata$idgroup <- unlist(idgroup)
```

(1) Thanks to Alex Acs for the code

Recoding variables

```
library(car)

mydata$Age.rec <- recode(mydata$Age, "18:19='18to19';
                   20:29='20to29';
                   30:39='30to39'")

mydata$Age.rec <- as.factor(mydata$Age.rec)
```

Sort

```
mydata.sorted <- mydata[order(mydata$Gender),]

mydata.sorted1 <- mydata[order(mydata$Gender, -mydata$SAT),]
```

Deleting variables

```
mydata$Age.rec <- NULL
mydata$var1 <- mydata$var2 <- NULL

(see subset next page)
```

Deleting rows

```
(see subset next page)
```

Subsetting variables

```
mydata2 <- mydata[,1:14] # Selecting the first 14 variables
mydata2 <- mydata[c(1:14)]

sat <- mydata[c("Last", "First", "SAT")]
sat1 <- mydata[c(2,3,11)]

select <- mydata[c(1:3, 12:14)]   # Type names(select) to verify
select1 <- mydata[c(-(1:3), -(12:14))]  # Excluding variables
```

Subsetting observations

```
mydata2 <- mydata2[1:30,] # Selecting the first 30 observations

mydata3a <- mydata[which(mydata$Gender=='Female' & mydata$SAT > 1800), ]
```

Subsetting variables/observations

```
mydata2 <- mydata2[1:30,1:14]    # Selecting the first 30 observations and first 14 variables
```

Subsetting using –subset--

```
mydata3 <- subset(mydata2, Age >= 20 & Age <= 30)
mydata4 <- subset(mydata2, Age >= 20 & Age <= 30, select=c(ID, First, Last, Age))
mydata5 <- subset(mydata2, Gender=="Female" & Status=="Graduate" & Age >= 30)
mydata6 <- subset(mydata2, Gender=="Female" & Status=="Graduate" & Age == 30)
```

Categorical data: Frequencies/Crosstabs

```
table(mydata$Gender)
table(mydata$Read)

# Two-way tables

readgender <- table(mydata$Read,mydata$Gender)
readgender
addmargins(readgender)   # Adding row/col margins

prop.table(readgender,1)             # Row proportions
round(prop.table(readgender,1), 2)   # Round col prop to 2 digits
round(100*prop.table(readgender,1), 2)   # Round col prop to 2 digits (percents)
addmargins(round(prop.table(readgender,1), 2),2)   # Round col prop to 2 digits

prop.table(readgender,2)             # Column proportions
round(prop.table(readgender,2), 2)   # Round column prop to 2 digits
round(100*prop.table(readgender,2), 2)   # Round column prop to 2 digits (percents)
addmargins(round(prop.table(readgender,2), 2),1)   # Round col prop to 2 digits

prop.table(readgender)     # Tot proportions
round(prop.table(readgender),2)   # Tot proportions rounded
round(100*prop.table(readgender),2)   # Tot proportions rounded

chisq.test(readgender)     # Do chisq test Ho: no relathionship
fisher.test(readgender)    # Do fisher'exact test Ho: no relationship

install.packages("vcd")
library(vcd)
assocstats(readgender)   # First two are assoc measures, last three show degree of association.

# 3-way crosstabs

table3 <- xtabs(~Read+Major+Gender, data=mydata)
table3
ftable(table3a)

# NOTE: Chi-sqr = sum (obs-exp)^2/exp. Degrees of freedom for Chi-sqr are (r-1)*(c-1)
# NOTE: Chi-sqr contribution = (obs-exp)^2/exp
# Cramer's V = sqrt(Chi-sqr/N*min).  Where N is sample size and min is a the minimum of (r-1) or (c-1)
```

Categorical data: Frequencies/Crosstabs using –gmodels--

```
library(gmodels)

mydata$ones <- 1       # Create a new variable of ones

CrossTable(mydata$Major,digits=2)      # Shows horizontal

CrossTable(mydata$Major,digits=2, max.width=1)  # Shows vertical

CrossTable(mydata$Major,mydata$ones, digits=2)

CrossTable(mydata$Gender,mydata$ones, digits=2)

CrossTable(mydata$Major,mydata$Gender,digits=2, expected=TRUE,dnn=c("Major","Gender"))

CrossTable(mydata$Major,mydata$Gender,digits=2, chisq=TRUE, dnn=c("Major","Gender"))

CrossTable(mydata$Major,mydata$Gender,digits=2, dnn=c("Major","Gender"))

CrossTable(mydata$Major,mydata$Gender, format=c("SPSS"), digits=1)

chisq.test(mydata$Major,mydata$Gender)          # Null hipothesis: no association
```

```
# NOTE: Expected value = (row total * column total)/overall total (or total sample size).
Value we would expect if all cell were represented proportionally, which
indicates no association between variables. This is are we getting what we
expect or not. If so then nothing is new. If not then something is going on
http://www.johndawes.com.au/page1/files/page1_2.pdf
http://faculty.chass.ncsu.edu/garson/PA765/chisq.htm
http://faculty.uml.edu/jstowell/docs/ppt/chapter_09_slides.pdf

# NOTE: Chi-sqr = sum (obs-exp)^2/exp
Degrees of freedom for Chi-sqr are (r-1)*(c-1)
# NOTE: Chi-sqr contribution = (obs-exp)^2/exp
# Cramer's V = sqrt(Chi-sqr/N*min)
Where N is sample size and min is a the minimun of (r-1) or (c-1)
```

Measures of association

X^2(chi-square) tests for relationships between variables. The null hypothesis (Ho) is that there is no relationship. To reject this we need a Pr < 0.05 (at 95% confidence). Here both chi2 are significant. Therefore we conclude that there is some relationship between perceptions of the economy and gender. lrchi2 reads the same way.

Cramer's *V* is a measure of association between two nominal variables. It goes from 0 to 1 where 1 indicates strong association (for rXc tables). In 2x2 tables, the range is -1 to 1. Here the V is 0.15, which shows a small association.

Fisher's exact test is used when there are very few cases in the cells (usually less than 5). It tests the relationship between two variables. The null is that variables are independent. Here we reject the null and conclude that there is some kind of relationship between variables

Source: http://dss.princeton.edu/training/StataTutorial.pdf

Plotting frequencies

```
barplot(margin.table(readgender,1))
barplot(margin.table(readgender,2))
```

Descriptive Statistics using –pastecs--

```
install.packages("pastecs")

library(pastecs)

stat.desc(mydata)

stat.desc(mydata[,c("Age","SAT","Score","Height", "Read")])

stat.desc(mydata[,c("Age","SAT","Score")], basic=TRUE, desc=TRUE, norm=TRUE, p=0.95)

stat.desc(mydata[10:14], basic=TRUE, desc=TRUE, norm=TRUE, p=0.95)
```

Descriptive Statistics

```
mean(mydata)         # Mean of all numeric variables
mean(mydata$SAT)
with(mydata, mean(SAT))

median(mydata$SAT)
var(mydata$SAT)      # Variance
sd(mydata$SAT)       # Standard deviation
max(mydata$SAT)      # Max value
min(mydata$SAT)      # Min value
range(mydata$SAT)    # Range
quantile(mydata$SAT) # Quantiles 25%
quantile(mydata$SAT, c(.3,.6,.9))   # Customized quantiles
fivenum(mydata$SAT)     # Boxplot elements. From help: "Returns Tukey's five number summary (minimum,
                        # lower-hinge, median, upper-hinge, maximum) for the input data ~ boxplot"
length(mydata$SAT)      # Num of observations when a variable is specify
length(mydata)          # Number of variables when a dataset is specify
which.max(mydata$SAT)   # From help: "Determines the location, i.e., index of the (first) minimum or maximum of a
   numeric vector"
which.min(mydata$SAT)   # From help: "Determines the location, i.e., index of the (first) minimum or maximum of a
   numeric vector”

# Mode by frequencies
table(mydata$Country)
max(table(mydata$Country))
names(sort(-table(mydata$Country)))[1]
```

Descriptive Statistics

```
# Descriptive statistics by groups using --tapply--

mean <- tapply(mydata$SAT,mydata$Gender, mean) # Add na.rm=TRUE to remove missing values in the
 estimation
sd <- tapply(mydata$SAT,mydata$Gender, sd)
median <- tapply(mydata$SAT,mydata$Gender, median)
max <- tapply(mydata$SAT,mydata$Gender, max)
cbind(mean, median, sd, max)
round(cbind(mean, median, sd, max),digits=1)
t1 <- round(cbind(mean, median, sd, max),digits=1)
t1

# Descriptive statistics by groups using --aggregate—

aggregate(mydata[c("Age","SAT")],by=list(sex=mydata$Gender), mean, na.rm=TRUE)
aggregate(mydata[c("Age","SAT")],mydata["Gender"], mean, na.rm=TRUE)
aggregate(mydata,by=list(sex=mydata$Gender), mean, na.rm=TRUE)
aggregate(mydata,by=list(sex=mydata$Gender, major=mydata$Major, status=mydata$Status), mean,
                 na.rm=TRUE)
aggregate(mydata$SAT,by=list(sex=mydata$Gender, major=mydata$Major, status=mydata$Status), mean,
                 na.rm=TRUE)
aggregate(mydata[c("SAT")],by=list(sex=mydata$Gender, major=mydata$Major, status=mydata$Status),
                 mean, na.rm=TRUE)
```

Histograms

```
library(car)
head(Prestige)
hist(Prestige$income)
hist(Prestige$income, col="green")
with(Prestige, hist(income)) # Histogram of income with a nicer title.

# Applying Freedman/Diaconis rule p.120 ("Algorithm that chooses bin widths and locations
  automatically, based on the sample size and the spread of the data"
  http://www.mathworks.com/help/toolbox/stats/bqucg6n.html)
with(Prestige, hist(income, breaks="FD", col="green"))
box()

hist(Prestige$income, breaks="FD")
# Conditional histograms
par(mfrow=c(1, 2))
hist(mydata$SAT[mydata$Gender=="Female"], breaks="FD", main="Female", xlab="SAT",col="green")
hist(mydata$SAT[mydata$Gender=="Male"], breaks="FD", main="Male", xlab="SAT", col="green")
# Braces indicate a compound command allowing several commands with 'with' command
par(mfrow=c(1, 1))
with(Prestige, {
                  hist(income, breaks="FD", freq=FALSE, col="green")
                  lines(density(income), lwd=2)
                  lines(density(income, adjust=0.5),lwd=1)
                  rug(income)
})
```

Histograms

```
# Histograms overlaid

hist(mydata$SAT, breaks="FD", col="green")

hist(mydata$SAT[mydata$Gender=="Male"], breaks="FD", col="gray", add=TRUE)

legend("topright", c("Female","Male"), fill=c("green","gray"))

# Check

satgender <- table(mydata$SAT,mydata$Gender)
satgender
```

Histogram with normal curve overlay

```
x <- rnorm(100)
hist(x, freq=F)
curve(dnorm(x), add(T)

h <- hist(x, plot=F)
ylim <- range(0. h$density, dnorm(0))
hist(x, freq=F, ylim=ylim)
curve(dnorm(x), add=T)
```

Scatterplots

```
# Scatterplots. Useful to 1) study the mean and variance functions in the regression of y on x p.128;
2)to identify outliers and leverage points.

# plot(x,y)

plot(mydata$SAT) # Index plot
plot(mydata$Age, mydata$SAT)
plot(mydata$Age, mydata$SAT, main=“Age/SAT", xlab=“Age", ylab=“SAT", col="red")
abline(lm(mydata$SAT~mydata$Age), col="blue")
        # regression line (y~x)
lines(lowess(mydata$Age, mydata$SAT), col="green") # lowess line (x,y)
identify(mydata$Age, mydata$SAT, row.names(mydata))

# On row.names to identify. "All data frames have a row names attribute, a character vector of length
the number of rows with no duplicates nor missing values." (source link below).
# "Use attr(x, "row.names") if you need an integer value.)" http://stat.ethz.ch/R-manual/R-
devel/library/base/html/row.names.html

mydata$Names <- paste(mydata$Last, mydata$First)
row.names(mydata) <- mydata$Names
plot(mydata$SAT, mydata$Age)
identify(mydata$SAT, mydata$Age, row.names(mydata))
```

Scatterplots

```
# Rule on span for lowess, big sample smaller (~0.3), small sample bigger (~0.7)

library(car)

scatterplot(SAT~Age, data=mydata)

scatterplot(SAT~Age, id.method="identify", data=mydata)

scatterplot(SAT~Age, id.method="identify", boxplots= FALSE, data=mydata)

scatterplot(prestige~income, span=0.6, lwd=3, id.n=4, data=Prestige)

# By groups

scatterplot(SAT~Age|Gender, data=mydata)

scatterplot(SAT~Age|Gender, id.method="identify", data=mydata)

scatterplot(prestige~income|type, boxplots=FALSE, span=0.75, data=Prestige)

scatterplot(prestige~income|type, boxplots=FALSE, span=0.75, col=gray(c(0,0.5,0.7)), data=Prestige)
```

Scatterplots (multiple)

```
scatterplotMatrix(~ prestige + income + education + women, span=0.7, id.n=0, data=Prestige)

pairs(Prestige)   # Pariwise plots. Scatterplots of all variables in the dataset
pairs(Prestige, gap=0, cex.labels=0.9) # gap controls the space between subplot and cex.labels the
                 font size (Dalgaard:186)
```

3D Scatterplots

```
library(car)

scatter3d(prestige ~ income + education, id.n=3, data=Duncan)
```

Scatterplots (for categorical data)

```
plot(vocabulary ~ education, data=Vocab)

plot(jitter(vocabulary) ~ jitter(education), data=Vocab)

plot(jitter(vocabulary, factor=2) ~ jitter(education, factor=2), data=Vocab)

# cex makes the point half the size, p. 134

plot(jitter(vocabulary, factor=2) ~ jitter(education, factor=2), col="gray", cex=0.5, data=Vocab)
with(Vocab, {
                  abline(lm(vocabulary ~ education), lwd=3, lty="dashed")
                  lines(lowess(education, vocabulary, f=0.2), lwd=3)
})
```

Useful links to graphics

http://www.stat.auckland.ac.nz/~paul/RGraphics/rgraphics.html

http://addictedtor.free.fr/graphiques/

http://addictedtor.free.fr/graphiques/thumbs.php?sort=votes

http://www.statmethods.net/advgraphs/layout.html

Exercises

Exercise 1

Using the ICPSR Online Learning Center, go to guide on *Civic Participation and Demographics in Rural China (1990)*
http://www.icpsr.umich.edu/icpsrweb/ICPSR/OLC/guides/China/sections/a01

Got to the tab 'Dataset' and download the data (http://www.icpsr.umich.edu/icpsrweb/ICPSR/OLC/guides/China/sections/a02)

We'll focus on the first exercise on 'Age and Participation' and use the following variables:

- Respondent's year of birth (M1001)
- Village meeting attendance (M3090)

Activities:

- Create the variable 'age' for each respondent
- Create the variable 'agegroup' with the following categories: 16-35, 36-55 and 56-79

Questions:

- What percentage of respondents reported attending a local village meeting?
- Of those attending a meeting, which age group was most likely to report attending a village meeting?
- Of those attending a meeting , which group was most likely to report no village meeting attendance?

Source: Inter-university Consortium for Political and Social Research. Civic Participation and Demographics in Rural China: A Data-Driven Learning Guide. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], July, 31 2009. Doi:10.3886/China

Exercise 2

Got to the *World Development Indicators (WDI) & Global Development Finance (GDF)* from the World Bank (access from the library's *Articles and Databases,* http://library.princeton.edu/catalogs/articles.php)

Direct link to WDI/GDF http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2

Get data for the United States and **all** available years on:

- Long-term unemployment (% of total unemployment)
- Long-term unemployment, female (% of female unemployment)
- Long-term unemployment, male (% of male unemployment)
- Inflation, consumer prices (annual %)
- GDP per capita (constant 2000 US$)
- GDP per capita growth (annual %)

See here to arrange the data as panel data http://dss.princeton.edu/training/FindingData101.pdf#page=21
For an example of how panel data looks like click here: http://dss.princeton.edu/training/DataPrep101.pdf#page=3

Activities:

- Rename the variables and explore the data (use describe, summarize)
- Create a variable called crisis where it takes the value of 17 for the following years: 1960, 1961, 1969, 1970, 1973, 1974, 1975, 1981, 1982, 1990, 1991, 2001, 2007, 2008, 2009. Replace missing with zeros (source: nber.org).
- Set as time series (see http://dss.princeton.edu/training/TS101.pdf#page=6)
- Create a line graph with unemployment rate (total, female and males) and crisis by year.

Questions:

- What do you see? Who tends to be more affected by the economic recessions?

References/Useful links

- DSS Online Training Section http://dss.princeton.edu/training/
- Princeton DSS Libguides http://libguides.princeton.edu/dss
- John Fox’s site http://socserv.mcmaster.ca/jfox/
- Quick-R http://www.statmethods.net/
- UCLA Resources to learn and use R http://www.ats.ucla.edu/stat/R/
- UCLA Resources to learn and use Stata http://www.ats.ucla.edu/stat/stata/
- DSS - Stata http://dss/online_help/stats_packages/stata/
- DSS - R http://dss.princeton.edu/online_help/stats_packages/r

References/Recommended books

- *An R Companion to Applied Regression*, Second Edition / John Fox , Sanford Weisberg, Sage Publications, 2011
- *Data Manipulation with R* / Phil Spector, Springer, 2008
- *Applied Econometrics with R* / Christian Kleiber, Achim Zeileis, Springer, 2008
- *Introductory Statistics with R* / Peter Dalgaard, Springer, 2008
- *Complex Surveys. A guide to Analysis Using R* / Thomas Lumley, Wiley, 2010
- *Applied Regression Analysis and Generalized Linear Models* / John Fox, Sage, 2008
- *R for Stata Users* / Robert A. Muenchen, Joseph Hilbe, Springer, 2010
- *Introduction to econometrics* / James H. Stock, Mark W. Watson. 2nd ed., Boston: Pearson Addison Wesley, 2007.
- *Data analysis using regression and multilevel/hierarchical models* / Andrew Gelman, Jennifer Hill. Cambridge ; New York : Cambridge University Press, 2007.
- *Econometric analysis* / William H. Greene. 6th ed., Upper Saddle River, N.J. : Prentice Hall, 2008.
- *Designing Social Inquiry: Scientific Inference in Qualitative Research / Gary King, Robert O. Keohane, Sidney Verba, Princeton University Press*, 1994.
- *Unifying Political Methodology: The Likelihood Theory of Statistical Inference* / Gary King, Cambridge University Press, 1989
- *Statistical Analysis: an interdisciplinary introduction to univariate & multivariate methods /* Sam

  Kachigan, New York : Radius Press, c1986
- *Statistics with Stata (updated for version 9) /* Lawrence Hamilton, Thomson Books/Cole, 2006